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(56) Literature Cited: Kokai 63-77404 (JP, A)

(54) [Title of the Invention] **Electrically powered toothbrush**

(57) [Claims]

[Claim 1] An electrically powered toothbrush comprising a pinion 22 attached to the upper output shaft 21 of a motor 13 housed within a casing 10 and switchable between normal and reverse [operation], rotation of said pinion 22 causing a brush attachment shaft 15 to move via a motion direction-converting cam portion 14 housed within the casing, wherein said electrically powered toothbrush is characterized in that said motion direction-converting cam portion 14 comprises:

- a) a face gear 27 meshing with the pinion at a right angle;
- b) an eccentric cam 29 integrally attached to the face gear 27 with the axis L2 thereof [arranged] eccentrically with respect to the axis L1 of the pivot shaft 26 of the face gear;
- c) a direction-converting cam receiving tube 30 having at a first end thereof a first oval orifice 31 mating with the eccentric cam 29, and at a second end thereof a second oval orifice 33 whose major axis is at a right angle to the major axis of said first oval orifice 31, and which does not mate with said eccentric cam, said two oval orifices 31, 33 having the pivot shaft 26 passed therethrough; and
- d) an annular ring 35 mating with the exterior peripheral surface of said direction-converting cam receiving tube 30 and linked to a flange attachment shaft 15;

and wherein stoppers 34, 36 for restricting rotation of said direction-converting cam receiving tube 30 to a range of approximately 90° are formed between said direction-converting cam receiving tube 30 and said annular ring 35; the direction of the major axis of said first oval orifice 31 of said direction-converting cam receiving tube 30 is switchable, by means of normal or reverse operation of said motor 13, between a direction [coinciding with] the axis of the flange attachment shaft and a direction at a right angle to said axis; and said direction-converting cam receiving tube 30 is moveable in the direction of the minor axis of said first oval orifice 31 and restricted in motion in the direction of the minor axis of said second oval orifice 32, whereby said flange

attachment shaft 15 is capable of rocking reciprocating motion about the axis or linear reciprocating motion along the axis.

[Detailed Description of the Invention]

[0001]

[Field of Industrial Utilization] The present invention relates to an electrically powered toothbrush wherein rotational motion of the motor can be varied between linear reciprocating motion and rocking reciprocating motion, i.e. brush motion can be switched between "bus"¹ type and "rolling" type [brushing action].

[0002]

[Prior Art] In recent years there have been developed and proposed electrically powered toothbrushes of switchable bus/rolling type, for example, that disclosed in Unexamined Patent Application 63-77404. In electrically powered toothbrushes of this design, the motor shaft of an internal motor is linked to a brush attachment shaft (the operating element) via a pinion, face gear, and motion direction-converting cam portion comprising a first eccentric cam portion for linear motion and a second eccentric cam portion for oscillatory reciprocating motion.

[0003] With this arrangement, the brush attachment shaft can be made to selectively undergo linear motion in the axial direction or oscillating motion at a given angle about its axis, through forward/reverse operation of the internal motor.

[0004]

[Problems the Invention Is Intended to Solve] However, electrically powered toothbrushes proposed to date still have a number of problems that remain to be solved, such as the following.

[0005] In the electrically powered toothbrush under discussion, the motion direction-converting cam portion comprises a first eccentric cam portion for linear motion and a second eccentric cam portion for oscillatory reciprocating motion, these being composed of concentrically arranged, integral elements. Such an arrangement requires precision

¹ [Translator's note: the Japanese usage of "bus" appears to have no English equivalent and may be an idiosyncratic usage by Matsushita Electric Works; see also their US Patent 5,504, 959 which defines "bus" motion as motion whereby "the toothbrush moves in a reciprocating rectilinear fashion in the direction of the axis of its handle."]

[machining] of the cam faces, requiring careful control of eccentric cam dimensions during the component production stage.

[0006] It is therefore an object of the present invention to provide an electrically powered toothbrush that solves the above problem.

[0007]

[Means for Solving the Problems] The invention herein relates to an electrically powered toothbrush comprising a pinion 22 attached to the upper output shaft 21 of a motor 13 housed within a casing 10 and switchable between normal and reverse [operation], rotation of said pinion 22 causing a brush attachment shaft 15 to move via a motion direction-converting cam portion 14 housed within the casing, wherein said electrically powered toothbrush is characterized in that said motion direction-converting cam portion 14 comprises:

- a) a face gear 27 meshing with the pinion at a right angle;
- b) an eccentric cam 29 integrally attached to the face gear 27 with the axis L2 thereof [arranged] eccentrically with respect to the axis L1 of the pivot shaft 26 of the face gear;
- c) a direction-converting cam receiving tube 30 having at a first end thereof a first oval orifice 31 mating with the eccentric cam 29, and at a second end thereof a second oval orifice 33 whose major axis is at a right angle to the major axis of said first oval orifice 31, and which does not mate with said eccentric cam, said two oval orifices 31, 33 having the pivot shaft 26 passed therethrough; and
- d) an annular ring 35 mating with the exterior peripheral surface of said direction-converting cam receiving tube 30 and linked to a flange attachment shaft 15;

and wherein stoppers 34, 36 for restricting rotation of said direction-converting cam receiving tube 30 to a range of approximately 90° are formed between said direction-converting cam receiving tube 30 and said annular ring 35; the direction of the major axis of said first oval orifice 31 of said direction-converting cam receiving tube 30 is switchable, by means of normal or reverse operation of said motor 13, between a direction [coinciding with] the axis of the flange attachment shaft and a direction at a right angle to said axis; and said direction-converting cam receiving tube 30 is moveable in the direction of the minor axis of said first oval orifice 31 and restricted in motion in

the direction of the minor axis of said second oval orifice 32, whereby said flange attachment shaft 15 is capable of rocking reciprocating motion about the axis or linear reciprocating motion along the axis.

[0008]

[Example] A fuller understanding of the invention is provided through the following detailed description of an exemplary embodiment, made with reference to the accompanying drawings.

[0009] (Overall construction of electrically powered toothbrush A) First, the overall construction of an electrically powered toothbrush A pertaining to the invention is described making reference to Fig. 1.

[0010] As shown in the drawing, electrically powered toothbrush A comprises an elongated hollow cylindrical casing 10 and, housed therein going in order from bottom to top, a secondary induction coil 11, a secondary battery 12, a motor 13, a motion direction-converting cam portion 14, and a brush attachment shaft 15; the operating element --namely, a brush head (not shown)-- is detachably attached to the brush attachment shaft 15.

[0011] On the peripheral wall of the casing 10 is provided a control switch 16 for switching on and off the [supply of power to] motor 13 from secondary battery 12, and for switching between positive and reverse polarity to operate the a motion direction-converting cam portion 14 such that up-and-down motion (bus) or oscillating motion (rotary) is imparted to the brush attachment shaft 15.

[0012] The secondary battery 12 may be recharged by installing the secondary induction coil 11 of electrically powered toothbrush A on a primary induction coil (not shown) provided to a recharger.

[0013] (Motion direction-converting cam portion 14) The construction of the motion direction-converting cam portion 14 which constitutes an essential feature of the invention is now described.

[0014] In Fig. 1, motor 13 --which is arranged enclosed by a motor casing 20 in the central portion of casing 1 [sic]-- has a pinion 22 attached to a motor output shaft 21 attached to the top thereof.

[0015] The top panel 23 of the motor casing 20 has a pair of bearing plates 24, 25 projecting upward parallel to each other a predetermined spacing apart. The two ends of a pivot 26 are supported on bearing plates 24, 25.

[0016] As illustrated in Figs. 1, 3 and 4, pivot 26 has rotatably mounted thereon thereof a gear attachment cylinder 28 having an integral face gear 27 at a first end thereof; this face gear 27 normally meshes with pinion 22.

[0017] An eccentric cam 29 is integrally attached to the integral face gear 27 end of the gear attachment cylinder 28; as shown in Fig. 5 the axis L2 of eccentric cam 29 is eccentric, by an amount of eccentricity e , with respect to the axis L1 of gear attachment cylinder 28 (face gear 27).

[0018] As shown in Fig. 4, an annular, direction-converting cam follower tube 30 is attached about the outside peripheral surface of eccentric cam 29; a first end of this follower tube 30 has a first elliptical orifice 31 whose minor axis is equal [in length] to the diameter of eccentric cam 29, and a major axis whose length is at least equal to twice the eccentricity of eccentric cam 29, plus the diameter of eccentric cam 29.

[0019] As shown in Figs. 4, 6 and 7, cam follower tube 30 additionally has at a second end thereof a second elliptical orifice 33 extending at a 90° right angle to the first elliptical orifice 31 attached about eccentric cam 29.

[0020] The gear attachment cylinder 28 mentioned previously inserts into this second elliptical orifice 33. The second elliptical orifice 33 has a minor axis equal [in length] to the diameter of gear attachment cylinder 28, and a major axis whose length is at least equal to twice the eccentricity of eccentric cam 29, plus the diameter of gear attachment cylinder 28.

[0021] The peripheral portion 32 of the cam follower tube 30 additionally comprises a first arcuate stopper 34 extending perpendicular to the second elliptical orifice 33, over a 180° angle of circumference.

[0022] An annular ring 35 fits onto this peripheral portion 32; the annular ring 35 comprises a 90° second arcuate stopper 36. By means of rotation of the direction-converting cam follower tube 30, either of the end portions 36a, 36b of second arcuate

stopper 36 comes into abutment with either of the end portions 34a, 34b of the first arcuate stopper 34 having the 180° angle of circumference described above.

[0023] The first and second arcuate stoppers 34, 36 may be situated at arbitrary locations on the respective peripheral surfaces, with the minor axis of the first elliptical orifice 31 of direction-converting cam follower tube 30 positioned between alignment with and perpendicularity with respect to the brush attachment shaft 15. It is sufficient for stoppers 34, 36 to have end portions 34a, 34b, 36a, 36b; the medial portion of the arcuate shape is not critical and may be of rib configuration, for example.

[0024] In this example the first arcuate stopper 34 has its end portions 34a, 34b situated along the peripheral edge orthogonal to the major axis of the second elliptical orifice 33, thereby providing sufficient distance from the second elliptical orifice 33 that the second elliptical orifice 33 does not undergo deformation of the like due the impact force produced by abutment.

[0025] As shown in Fig. 4, annular ring 35 further comprises at the top end thereof a flange attachment shaft mating portion 40 composed of a pair of bracket retainers 37, 38 of rectangular configuration, and an insert post 39 connecting the two bracket retainers 37, 38.

[0026] To the bottom end of the flange attachment shaft 15 --which is arranged extending in the vertical direction-- is attached the basal end of an eccentric bracket 41 of rectangular tabular configuration, as shown in Fig. 4; the eccentric bracket 41 has a notched groove 42 of width approximately equal to the diameter of the insert post 39, and situated at a location on the distal edge thereof eccentric with respect to the axis L3 of the flange attachment shaft 15. The notched groove 42 extends and opens out radially from axis L3.

[0027] The insert post 39 at the top of annular ring 35 is inserted into the notched groove 42 to link the annular ring to the flange attachment shaft 15.

[0028] Symbol 43 in Fig. 4 denotes a sliding disk integrally formed with a side face of face gear 43; a slide resistance reducing element 44 that also serves as a positioning spacer is provided to the end face of direction-converting cam follower tube 30 juxtaposed to this side face.

[0029] (Operation of motion direction-converting cam portion 14)

The description turns first to oscillatory reciprocating motion of the flange attachment shaft 15 about its axis, i.e., rolling.

[0030] When the pinion 22 of motor 13 rotates in the counterclockwise direction b shown in Fig. 4, the face gear 27, together with the gear attachment cylinder 28 and eccentric cam 29 integral therewith, also rotate in the counterclockwise direction b.

[0031] Rotation of the eccentric cam 29 causes the outside peripheral wall of eccentric cam 29 to come into contact with the inside peripheral wall of the direction-converting cam follower tube 30, the frictional force of contact causing the direction-converting cam follower tube 30 to also attempt to rotate in the counterclockwise direction b; however, as shown in Fig. 6, as the first end 34a of the first arcuate stopper 34 provided on the peripheral surface of the peripheral portion 32 of direction-converting cam follower tube 30 is abutting the first end 36a of the second arcuate stopper 36 provided in the inside surface of annular ring 35, the direction-converting cam follower tube 30 cannot rotate in the counterclockwise direction b in Fig. 4 (in Fig. 6, which is viewed from the annular ring 35 side, the clockwise direction), and thus the first elliptical orifice 31 is held in the vertical attitude depicted in Fig. 4.

[0032] Thus, orbital motion of eccentric cam 29 in the counterclockwise direction b about axis L1 brings about left-to-right reciprocating motion of the direction-converting cam follower tube 30 as shown in Fig. 4.

[0033] When the direction-converting cam follower tube 30 is in the vertical attitude depicted in Fig. 4, the first elliptical orifice 31 thereof extends the vertical direction, so that rotation of the eccentric cam 29 results simply in up-and-down sliding motion in the first elliptical orifice 31, without the direction-converting cam follower tube 30 per se being moved up and down by rotation of the eccentric cam 29.

[0034] Specifically, rotation of the motor 13 brings the direction of the major axis of the first elliptical orifice 31 of cam follower tube 30 into alignment with the axial direction of the flange attachment shaft 15, and enables the cam follower tube 30 to move in the direction of the minor axis of the first elliptical orifice 31, while restricting movement thereof in the direction of the minor axis of the second elliptical orifice 33.

[0035] As a result, orbital motion of eccentric cam 29 in the counterclockwise direction b about axis L1 brings about interlocked left-to-right reciprocating motion of the direction-converting cam follower tube 30 and the annular ring 35 fitted about the peripheral surface thereof.

[0036] The insert post 39 provided at the top of the annular ring 35 undergoes left-to-right reciprocating motion together with the annular ring 35, and since the insert post 39 has been inserted into the notched groove 42 of the eccentric bracket 41, the flange attachment shaft 15 can undergo oscillating rotation about its axis L3.

[0037] Accordingly, the brush head B attached to the flange attachment shaft 15 also undergoes oscillating rotation, i.e., "rolling".

[0038] The description now turn to linear up-and-down reciprocating motion of the flange attachment shaft 15 about its axis, i.e., "bus" [motion].

[0039] When the pinion 22 of motor 13 rotates in the clockwise direction a shown in Fig. 4, the face gear 27, together with the gear attachment cylinder 28 and eccentric cam 29 integral therewith, also rotate in the clockwise direction a.

[0040] Rotation of the eccentric cam 29 causes the outside peripheral wall of eccentric cam 29 to come into contact with the inside peripheral wall of the direction-converting cam follower tube 30, the frictional force of contact causing the direction-converting cam follower tube 30 to attempt to rotate in the clockwise direction a.

[0041] As shown in Fig. 4, since the second end 34b of the first arcuate stopper 34 provided on the peripheral surface of the peripheral portion 32 of direction-converting cam follower tube 30 is not abutting the second end 36b of the second arcuate stopper 36 provided in the inside surface of annular ring 35, the frictional force of contact between the eccentric cam 30 [sic] and the direction-converting cam follower tube 30 causes the direction-converting cam follower tube 30 and the first arcuate stopper 34 integral therewith to rotate in the clockwise direction a.

[0042] Having rotated 90°, the second end 34b of the first arcuate stopper 34 now abuts the second end 36b of the second arcuate stopper 36, as depicted in Fig. 7, so that the direction-converting cam follower tube 30 moves to the horizontal attitude depicted in

Fig. 8 --i.e., rotated 90° from the vertical attitude depicted in Fig. 4-- and is held in this attitude.

[0043] As a result, orbital motion of eccentric cam 29 in the clockwise direction a about axis L1 brings about up-and-down reciprocating motion of the direction-converting cam follower tube 30.

[0044] When the direction-converting cam follower tube 30 is in the attitude depicted in Fig. 8, the first elliptical orifice 31 thereof extends the horizontal direction, so that rotation of the eccentric cam 29 results simply in left-to-right sliding motion in the first elliptical orifice 31, without the direction-converting cam follower tube 30 per se being moved left and right by rotation of the eccentric cam 29.

[0045] Specifically, rotation of the motor 13 brings the direction of the major axis of the first elliptical orifice 31 of cam follower tube 30 into an orthogonal relationship with the axial direction of the flange attachment shaft 15, enabling the cam follower tube 30 to move in the direction of the minor axis of the first elliptical orifice 31, while restricting movement thereof in the direction of the minor axis of the second elliptical orifice 33.

[0046] As a result, orbital motion of eccentric cam 29 in the clockwise direction a about axis L1 brings about interlocked up-and-down reciprocating motion of the direction-converting cam follower tube 30 and the annular ring 35 fitted about the peripheral surface thereof.

[0047] The flange attachment shaft mating portion 40 attached to at the top of the annular ring 35 undergoes up-and-down reciprocating motion together with the annular ring 35, and since the eccentric bracket 41 is held detained in the vertical direction by the upper and lower rectangular plates 37, 38 of flange attachment shaft mating portion 40, the eccentric bracket 41 and the flange attachment shaft 15 integral therewith can undergo up-and-down reciprocating motion in the axial directions L3.

[0048] Accordingly, the brush head B attached to the flange attachment shaft 15 also undergoes up-and-down reciprocating motion, i.e., "bus" [motion].

[0049] Alternating forward and reverse rotation of the eccentric cam 29 may be brought about by switching polarity of the DC motor 13, or by linking operation of the motor 13 output shaft 21 to the face gear 27 by means of an interposed idle gear, in which case it

will not be necessary to switch the polarity of the motor 13, thus extending the life of the motor 13.

[0050]

[Effects of the Invention] According to the invention set forth herein there is provided an electrically powered toothbrush comprising a pinion 22 attached to the upper output shaft 21 of a motor 13 housed within a casing 10 and switchable between normal and reverse [operation], rotation of said pinion 22 causing a brush attachment shaft 15 to move via a motion direction-converting cam portion 14 housed within the casing, wherein said motion direction-converting cam portion 14 comprises:

- a) a face gear 27 meshing with the pinion at a right angle;
- b) an eccentric cam 29 integrally attached to the face gear 27 with the axis L2 thereof [arranged] eccentrically with respect to the axis L1 of the pivot shaft 26 of the face gear;
- c) a direction-converting cam receiving tube 30 having at a first end thereof a first oval orifice 31 mating with the eccentric cam 29, and at a second end thereof a second oval orifice 33 whose major axis is at a right angle to the major axis of said first oval orifice 31, and which does not mate with said eccentric cam, said two oval orifices 31, 33 having the pivot shaft 26 passed therethrough; and
- d) an annular ring 35 mating with the exterior peripheral surface of said direction-converting cam receiving tube 30 and linked to a flange attachment shaft 15;

and wherein stoppers 34, 36 for restricting rotation of said direction-converting cam receiving tube 30 to a range of approximately 90° are formed between said direction-converting cam receiving tube 30 and said annular ring 35; the direction of the major axis of said first oval orifice 31 of said direction-converting cam receiving tube 30 is switchable, by means of normal or reverse operation of said motor 13, between a direction [coinciding with] the axis of the flange attachment shaft and a direction at a right angle to said axis; and said direction-converting cam receiving tube 30 is moveable in the direction of the minor axis of said first oval orifice 31 and restricted in motion in the direction of the minor axis of said second oval orifice 32, whereby said flange attachment shaft 15 is capable of rocking reciprocating motion about the axis or linear reciprocating motion along the axis; whereby the device may be switched between "bus"

and "rolling" brushing by means of a simple arrangement, the motion direction-converting cam portion may be simplified, and the electrically powered toothbrush can be made thinner in shape, making it easier to grasp.

[Brief Description of the Figures]

[Figure 1] A sectional front view of an electrically powered toothbrush employing a motion direction-converting mechanism according to the invention.

[Figure 2] A side view of one side of the electrically powered toothbrush with the casing removed.

[Figure 3] A lateral section taken along line I-I in Fig. 1.

[Figure 4] An exploded perspective view of the motion direction-converting cam portion in the rolling position.

[Figure 5] A view of the face gear taken along line II-II in Fig. 4.

[Figure 6] A view of the direction regulating ring and annular ring in the rolling position, taken along line III-III in Fig. 4.

[Figure 7] A view of the direction regulating ring and annular ring in the bus position, taken along line III-III in Fig. 4.

[Figure 8] An exploded perspective view of the motion direction-converting cam in bus position.

[Key]

A: electrically powered toothbrush

B: brush head

10: casing

13: motor

14: motion direction-converting cam portion

15: flange attachment shaft

22: pinion

27: face gear

26: pivot

28: gear attachment cylinder

29: eccentric cam

30: direction-converting cam follower tube

31: first elliptical orifice

32: peripheral portion

33: second elliptical orifice

34: first arcuate stopper

35: annular ring

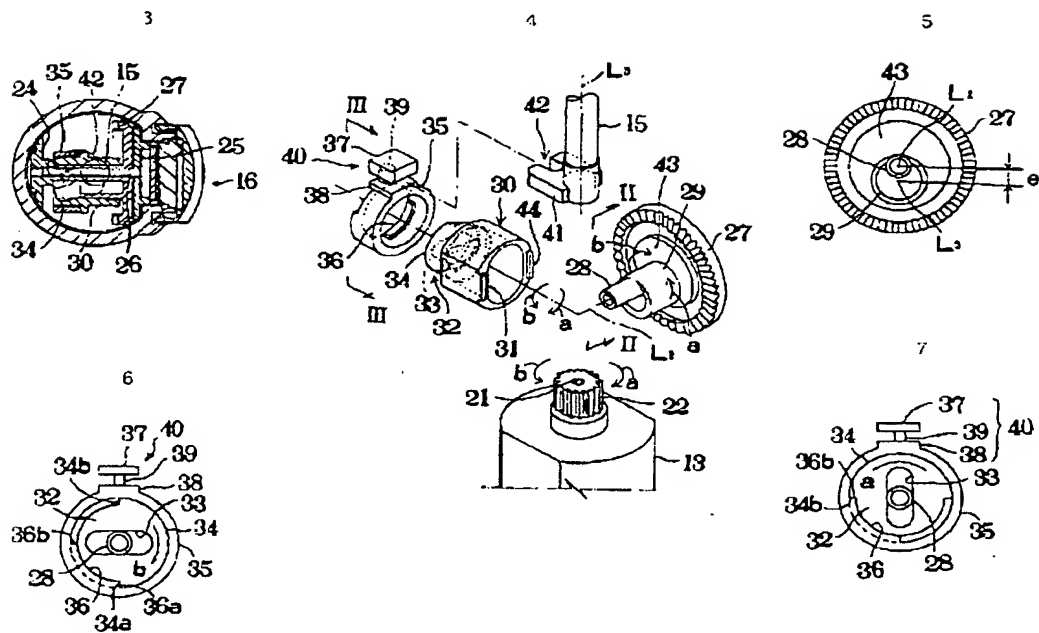
36: second arcuate stopper

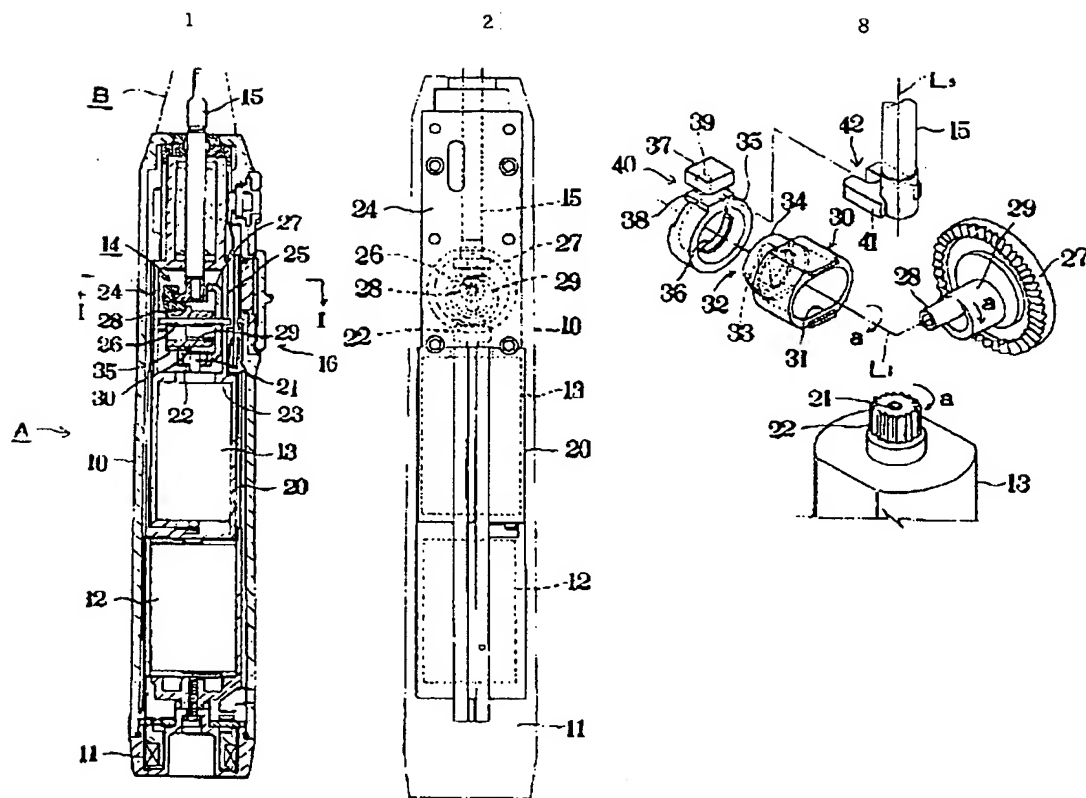
37: bracket detainer

39: insert post

41: bracket

42: notched groove





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